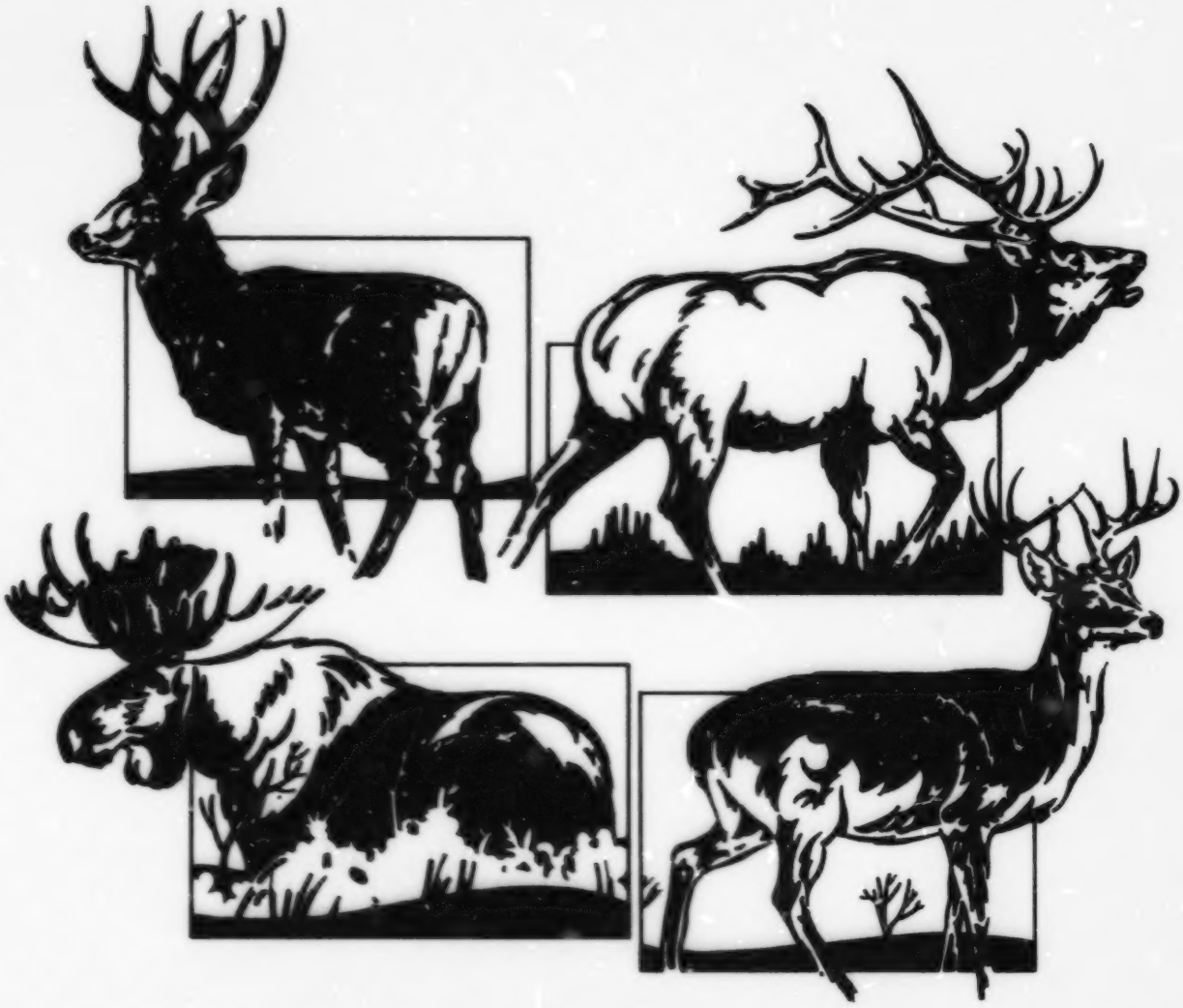
LUNG AND LIVER PARASITES OF BIG GAME IN ALBERTA, 1988



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LUNG AND LIVER PARASITES
OF BIG GAME IN ALBERTA, 1988

M.J. PYBUS,

Wildlife Worms

Currently: **Wildlife Disease Research Biologist**
Alberta Fish and Wildlife Division

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FOR COPIES OF THIS REPORT, CONTACT:

Fish and Wildlife Division
Alberta Forestry, Lands and Wildlife
7th Floor, O.S. Longman Building
6909 - 116 Street
Edmonton, Alberta, Canada T6H 4P2

OR

Information Centre
Alberta Energy/Forestry, Lands and Wildlife
Main Floor, Britannia Building
703 - 6th Avenue
Calgary, Alberta
Canada T2P 0T9

Telephone: (403) 297-6324

OR

Information Centre
Alberta Energy/Forestry, Lands and Wildlife
Main Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta,
Canada T5K 2M4

Telephone: (403) 427-3590

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ACKNOWLEDGEMENTS

The success of this survey primarily resulted from the enthusiastic cooperation of over 800 hunters who submitted liver and lung samples for examination. In many cases the hunters went to a lot of extra effort that certainly is appreciated. In addition, the office and field staff of the Alberta Fish and Wildlife Division were instrumental in receiving and transporting survey material. One and all are gratefully acknowledged.

Lyle Fullerton (Alberta Fish and Game Association), Sylvia Schurman and Ken Crutchfield (Alberta Fish and Wildlife Division), and Dwight Dobson (Saskatchewan Parks and Renewable Resources) assisted in distributing survey notices and media information. Dobson also collected samples from hunters in the Saskatchewan Cypress Hills.

This program was an independent research project conducted by M.J. Pybus, Wildlife Worms, in cooperation with the Alberta Fish and Wildlife Division. Financial support was provided by the Alberta Recreation, Parks and Wildlife Foundation and the Rocky Mountain Elk Foundation. Logistical support was provided by the Alberta Fish and Wildlife Division.

LUNG AND LIVER PARASITES OF BIG GAME IN ALBERTA, 1988

Occasional Paper Series Number 6

M. J. Pybus, Ph.D.
Alberta Fish and Wildlife Division
6909 - 116 Street
Edmonton, T6H 4P2

ABSTRACT

During the 1988 hunting season, livers and lungs from 263 Mule Deer (Odocoileus hemionus hemionus), 198 Moose (Alces alces), 147 White-tailed Deer (Odocoileus virginianus), and 94 Wapiti (Cervus elaphus) were collected for parasitological examination. Most of the samples (89%) were submitted by big game hunters throughout the province.

Giant liver fluke (Fascioloides magna) was found in 9.1% of 22 yearling and 29.2% of 65 adult Wapiti; 3.8% of 161 adult Moose; and 2.1% of 97 adult White-tailed Deer. The intensity of infection generally was low; however, one Wapiti had over 600 flukes in the liver. Most infections were in the alpine and montane regions south of the North Saskatchewan River (97% of the cases recorded).

Other parasites recorded included bladderworm (Taenia hydatigena) in the liver of 61% of 191 Moose and 14% of 247 Mule Deer; thread lungworm (Dictyocaulus viviparus) in the lungs of 14% of 50 Moose, 14% of 118 Mule Deer, 12% of 41 Wapiti, and 6% of 54 White-tailed Deer; and cysts of hydatid tapeworm (Echinococcus granulosus) in the lungs (and occasionally liver) of 37% of 51 Moose. Incidental infections of fringed tapeworm (Thysanosoma actinoides), mule deer lungworm (Orthostrongylus macrotis), and Taenia omissa were recorded. Adult lancet fluke (Dicrocoelium dendriticum) were collected from the liver of two Wapiti, one Mule Deer, and one White-tailed Deer from the Cypress Hills.

1.0 INTRODUCTION

Fascioloides magna, the giant liver fluke, is a well-known parasite of White-tailed Deer (Odocoileus virginianus) in eastern North America (Erhardova-Kotrla 1971; Foreyt 1981) (Figure 1). It also can infect a variety of wild and domestic species. Adult flukes usually are encapsulated in the liver, often in pairs, while immature worms migrate throughout liver tissue apparently until they locate another fluke. The parasite is relatively benign in White-tailed Deer, Black-tailed Deer (Odocoileus hemionus columbianus), Wapiti (Cervus elaphus), and Caribou (Rangifer tarandus) populations but can cause extensive damage in individual animals. In contrast, most infections in Moose (Alces alces), cattle, domestic sheep, and domestic goats result in significant damage to the liver and/or death of the host animal.

Historically, F. magna has been reported in Alberta in a variety of hosts from Buffalo National Park (which later became Camp Wainwright) (Cameron 1923; Swales 1935), Banff National Park (Flook and Stenton 1969), and the Waterton area in southwestern Alberta (Flook and Stenton 1969; Kingscote et al. 1987).

A recent survey (1984 to 1989) of F. magna in Banff and Kootenay National Parks (Pybus and Woods, unpubl. data) indicated an extremely high prevalence of the fluke in adult Wapiti (86%), Moose (85%) and White-tailed Deer (60%). A few infected Mule Deer, (Odocoileus hemionus hemionus), also were recorded (14%). It appears that the parasite recently moved into the lower Bow valley in southwestern Alberta where infections in Wapiti and Moose often were accompanied by extensive damage to liver tissue.

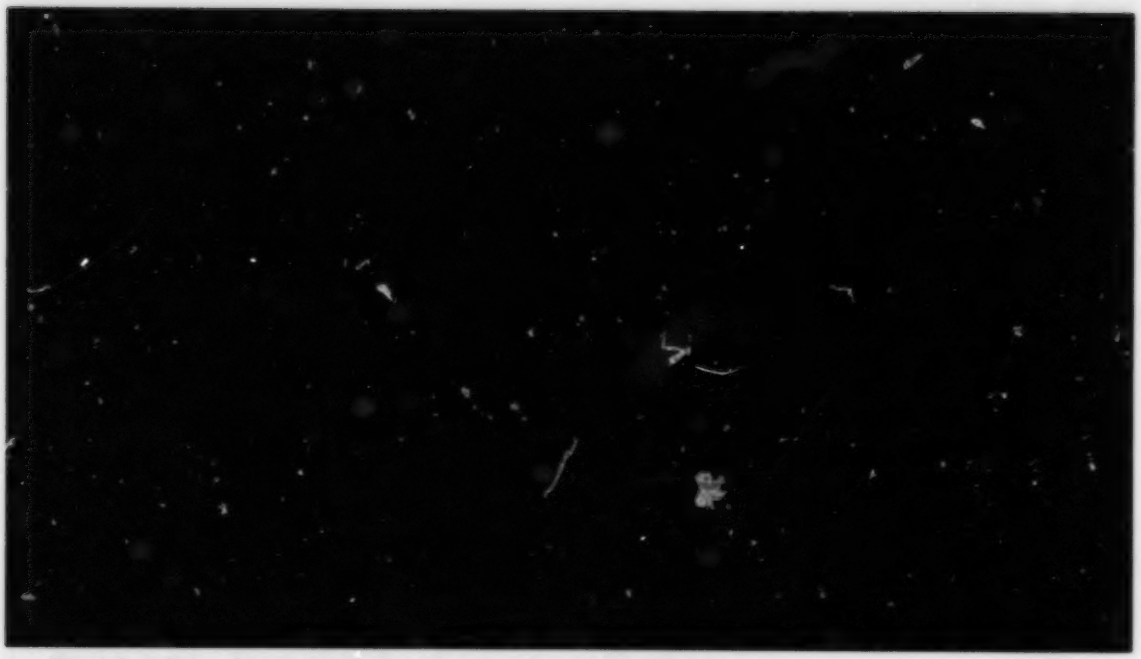
Giant liver fluke also has been found in Elk Island National Park in central Alberta (Pybus, unpubl. data). Since 1987, it has been found in the liver of 11 of 18 (61%) adult Wapiti and 2 of 26 (8%) adult Moose in the park. The number of flukes in infected individuals was low and all infected animals came from the area north of Highway 16.

Fascioloides magna is found in local areas throughout central and southeastern North America (Figure 2). It is a parasite that readily expands its range by natural dispersal or by translocation with infected hosts into new areas. As an example, the first report of F. magna was in Italy and followed the importation of Wapiti from western North America into Italy in 1875 (Bassi 1875). Giant liver fluke spread outwards from this initial introduction and became established in free-ranging wildlife populations. To this day, F. magna remains a major management concern throughout northeastern Europe. To avoid similar spread of the parasite by translocation of infected free-ranging animals or movement of infected captive animals in Alberta, it is necessary to know where and in which hosts liver fluke already exists in the province.

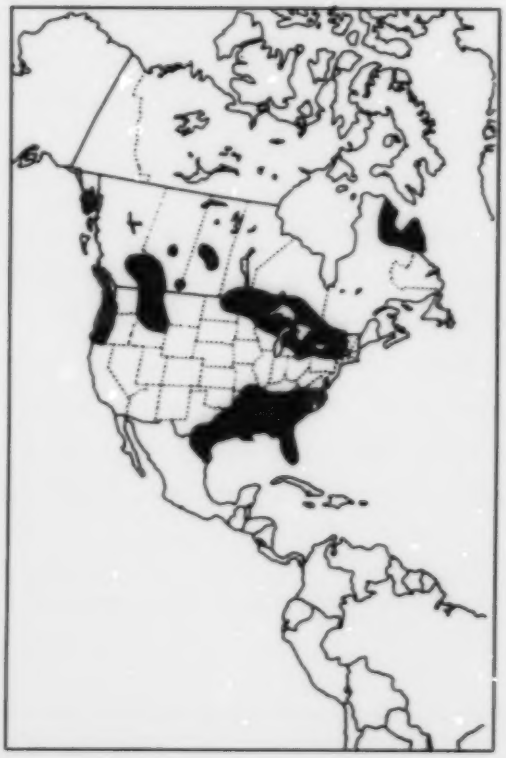
The goal of the 1988 survey was to define the present geographic and host distribution of the giant liver fluke throughout Alberta. Other parasites found also were noted. The program involved examination of liver and lungs from Wapiti, Moose, White-tailed Deer, and Mule Deer killed during the 1988 hunting season. [These results have been reported in the scientific literature (Pybus, 1990).]

2.0 MATERIALS AND METHODS

Cooperation of big game hunters throughout the province was



1. Giant liver fluke. Approximate size 30 mm wide and 75 mm long.



2. Distribution of *F. magna* in North America.

relied upon heavily for the collection of samples examined in this study. Various methods were used to notify hunters about the survey. These included direct contact with sportsmens groups (e.g., Alberta Fish and Game Association, The Wilderness Sportsmens Club) by way of notices and presentations; publication of articles and/or notices in sporting magazines (Alberta Fishing and Hunting Magazine, B.C. Outdoors, Western Sportsman); and notices mailed along with hunting licence draw notification to many successful draw applicants for the 1988 hunting season (Figure 3). Notices also were displayed in Fish and Wildlife offices before and during the hunting season. A press release providing background information and a request for samples was circulated to weekly and daily newspapers throughout the province. In addition Saskatchewan hunters in the Cypress Hills area were requested to submit samples for the Alberta survey and native hunters were notified of the survey at various Band Council meetings and asked to submit samples throughout 1988. Field staff of the Alberta Fish and Wildlife Division were requested to collect samples whenever the opportunity arose.

All persons collecting samples were requested to provide information about the date, location, species, sex, and age (juvenile or adult) of the animal. Most samples were frozen as soon as possible and taken to a Fish and Wildlife office. Samples from the Camp Wainwright deer hunt were collected within a few hours of the animal's death and examined fresh.

After the hunting season, frozen samples were transported to the O.S. Longman Building in Edmonton. Incomplete samples or those with missing information about location of the kill were not examined. The remaining livers were thawed, sliced thinly (5mm), and all flukes and/or evidence of damage was noted. Lungs were examined visually and the air passages were opened with scissors.

As part of a cooperative program with Saskatchewan Parks and Renewable Resources, incisor bars and female reproductive tracts collected from hunter-killed Wapiti from the Cypress Hills area were sent to Saskatchewan. Hunters who contributed to the Cypress Hills programs were sent lapel pins from each province.

The location of each sample, designated by Wildlife Management Unit (WMU), was assigned to one of eight major ecoregions (Strong and Leggat 1981). The ecoregions were grouped into four habitat types - aspen parkland; boreal uplands and northern mixedwoods; east slopes and foothills; and grasslands (Figure 4).

A subsample of the parasites collected was fixed, cleared and identified using standard methods and reference keys. Representative samples were deposited in the National Museum of Natural Sciences (Division of Invertebrate Zoology, Ottawa, Ontario K1A 0M8, Accession # NMCP1989-0537 to NMCP1989-0550).

3.0 RESULTS

Liver and often lungs from 702 animals were examined. Most were from animals killed by big game hunters (89%) from October to December 1988. Samples from 198 Moose, 263 Mule Deer, 147 White-tailed Deer and 94 Wapiti (Table 1, Appendix 1) were collected widely throughout the province from Clear Hills and Fort McMurray in the north to Milk River and Cypress Hills in the south.

ALBERTA HUNTERS

Your help is needed in a PARASITE SURVEY

Dr. Margo Pybus is conducting a survey of giant liver flukes in elk, moose, white-tails, and mule deer to find out where and how often the worms occur in Alberta. We know it kills some elk and may be a problem in maintaining moose populations. White-tailed deer apparently live quite nicely with the worms but we are unsure of its affects in mule deer.

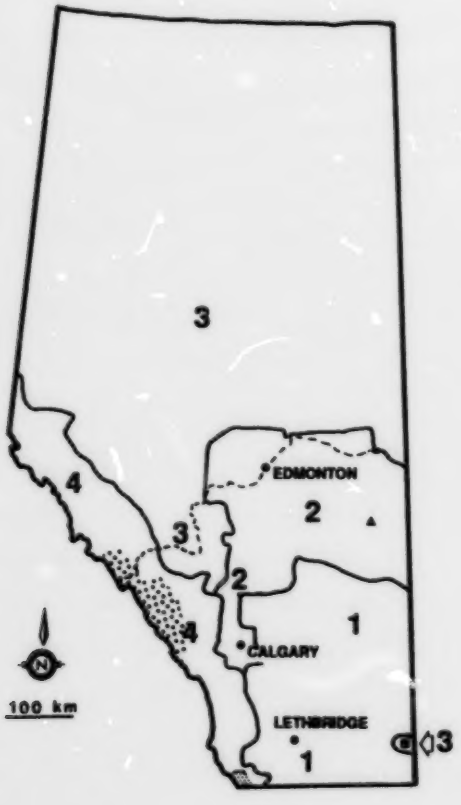
We need to examine entire livers and lungs from carcasses of elk, moose, white-tailed deer and mule deer. Samples should be **frozen** as soon as possible after death. A tag with the species, location, date, age (juvenile or adult), and sex should be attached. Samples can be dropped off at any Fish and Wildlife office or call me and we can make arrangements for transportation to Edmonton.

This parasite has important implications in elk and moose management (for example, in relocating animals and introducing the fluke into new areas) and in game farming activities (with subsequent loss of productivity of farmed animals and potential exposure of free-ranging populations). I would appreciate greatly your cooperation with this survey.

The program is funded by the Alberta Recreation, Parks and Wildlife Foundation in cooperation with Parks Canada and the Alberta Fish and Wildlife Division.

For further information contact Margo Pybus (436-9422). A report of the findings will be available at the end of the survey (April, 1989).

3. Notice used to request hunters to collect lung and liver from four big game species killed during the 1988 hunting season.



4. Major habitat types in Alberta (modified to accommodate Wildlife Management Unit boundaries).

Legend

- 1 Grasslands
- 2 Aspen parkland
- 3 Boreal upland and mixed wood
- 4 East slopes and foothills
- ▲ Camp Wainwright
- ▭ Cypress Hills
- ▭ Banff National Park
- ▭ Waterton National Park
- ---- North Saskatchewan River

TABLE 1: Source of animals examined in the survey.

Species	Cause of death				
	Hunter	Native	Motor vehicle	Other	Total
Wapiti	66	7	15	6	94
Moose	190	1	4	3	198
Mule deer	237	4	11	11	263
White-tailed deer	116	1	27	3	147
Total	609	13	57	23	702

TABLE 2: Distribution of samples in four major habitat types.

Habitat type	Wapiti	Moose	Mule deer	White-tailed deer	Total
Aspen parkland	2	2	70	81	155
Boreal upland and mixedwood	32	116	50	13	211
East slopes and foothills	41	80	31	18	170
Grasslands	19	0	112	35	166

Samples were collected in most WMUs, particularly in Cypress Hills (n=135) and Camp Wainwright (n=80). The rest of the sample was well-distributed among the four habitat types (Table 2).

3.1 Giant Liver Fluke

The giant liver fluke was found in the liver of 29 animals (Table 3, Appendix 2). These included 9.1% of yearling Wapiti, 29.2% of adult Wapiti, 3.8% of adult Moose, and 2.1% of adult White-tailed Deer. The prevalence (percent infected) was similar in males and females; however, the intensity (mean number of flukes per infected individual) was higher in male Wapiti than in female. One heavily infected adult male Wapiti (608 F. magna) differed markedly from all others and was not included in the comparison.

All but one infection of F. magna were found in animals located in the alpine or montane ecoregions in the east slopes and foothills of southwestern Alberta (Table 4). In these two ecoregions, liver flukes were recovered from 18 of 27 adult Wapiti (prevalence =67%) and 7 of 10 WMUs from which Wapiti were collected. The other infected Wapiti was collected in the boreal uplands and mixedwoods ecoregion in the Cypress Hills.

3.2 Other Parasites

Several other parasites were collected during this survey (Tables 4 and 5). These included four species of tapeworms: Echinococcus granulosus cysts (hydatid cysts) in the lungs and occasionally in the liver of 37 (73%) Moose and 6 (21%) Wapiti; Taenia hydatigena (bladderworm) cysts in the liver of 117 (61%) Moose, 34 (14%) Mule Deer, 7 (5%) White-tailed Deer and 2 (2%) Wapiti; Taenia omissa cysts in the lungs of 2 (0.8%) Mule Deer; and Thysanosoma actinoides (fringed tapeworm) in the liver of 8 (4%) Moose, 3 (3%) Wapiti, and 1 (0.4%) Mule Deer. In addition, two species of nematodes were recorded: Dictyocaulus viviparus (thread lungworm) in the lungs of 17 (14%) Mule Deer, 7 (14%) Moose, 5 (12%) Wapiti, and 3 (6%) White-tailed Deer; and Orthostrongylus macrotis (mule deer lungworm) in the lungs of 8 (3%) Mule Deer.

Dicrocoelium dendriticum, the lancet fluke, was found in the liver of 2 Wapiti, 1 Mule Deer, and 1 White-tailed Deer from the Cypress Hills. The infection in the Mule Deer was noteworthy because it involved enlargement of all major collecting tubules and extensive accumulation of thick yellow/brown material in tubules throughout the liver. A total of 174 flukes was collected from this deer.

4.0 DISCUSSION

4.1 Giant liver fluke

Of the parasites collected during this survey, the giant liver fluke is of greatest concern to wildlife managers (Figure 5). It can be a direct or indirect mortality factor in Moose (Olsen and Fenstermacher 1942; Karns 1972, 1973; Wobeser et al. 1985), Wapiti (Pybus and Woods, unpublished data), and Black-tailed Deer (Hadwen 1916; Cowan 1946). In addition, it can cause death of domestic sheep and goats (Foreyt 1981).

The giant liver fluke is common in Wapiti in the foothills and mountains of southern Alberta (Figure 6) and also occurs

TABLE 3: Giant liver fluke, Fascioloides magna, in samples surveyed during fall 1988.

Species	Number examined[a]				Prevalence (%)			Intensity	
	Total	YOY	YLG	Adult	YOY	YLG	Adult	YLG	Adult[b]
Wapiti	94	7	22	65	0	9.1	29.2	1, 36	25 ± 33, 1 - 115[c]
Moose	191	9	21	161	0	0	3.8	-	3 ± 1, 2 - 5
Mule deer	247	13	71	163	0	0	0	-	- -
White-tailed deer	140	20	23	97	0	0	2.1	-	- 3, 31

[a] Unaged animals not included; YOY = young-of-year; YLG = yearling.

[b] Mean number of worms ± SD, range.

[c] Does not include one wapiti with 608 flukes.

TABLE 4: Distribution of parasites in four major habitat types.

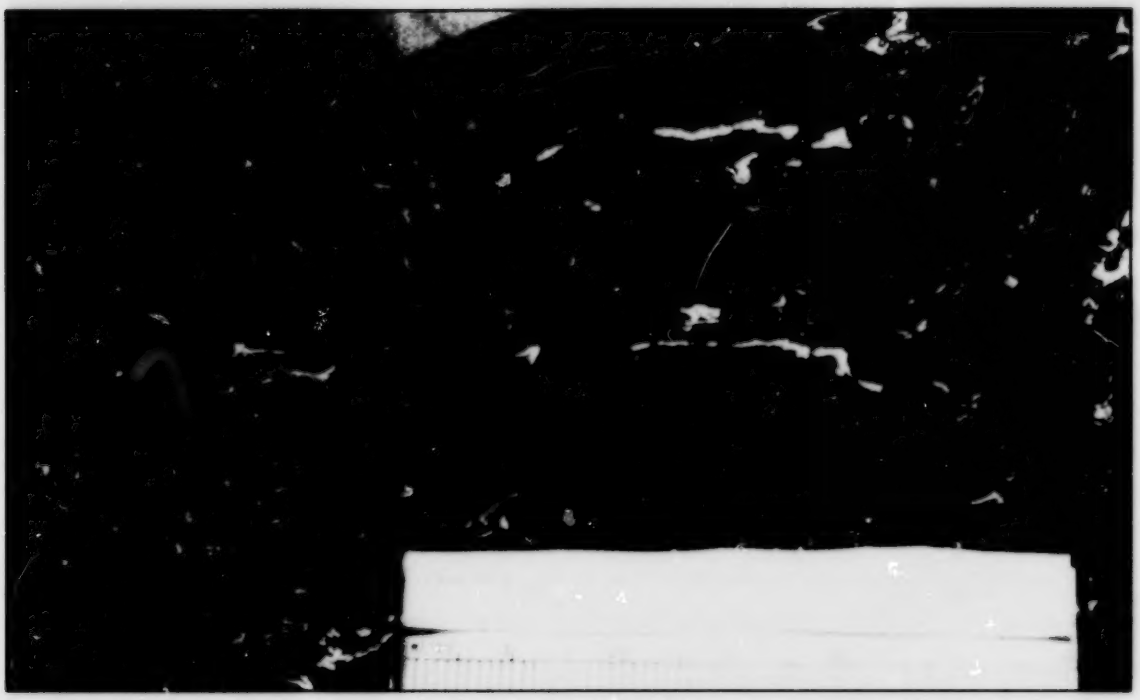
	Dictyocaulus viviparus	Echinococcus granulosus	Fascioloides magna	Taenia hydatigena	Thysanosoma actinoides
Number of infected animals	32	25	29	162	12
Aspen parkland	7 (22)[a]	0	0	13 (8)	0
Boreal upland and mixedwood	13 (41)	14 (56)	1 (3)	87 (54)	4 (33)
East slopes and foothills	7 (22)	11 (44)	28 (97)	50 (31)	8 (67)
Grasslands	5 (15)	0	0	12 (7)	0

[a] Number of cases in habitat type (% of total cases of each parasite).

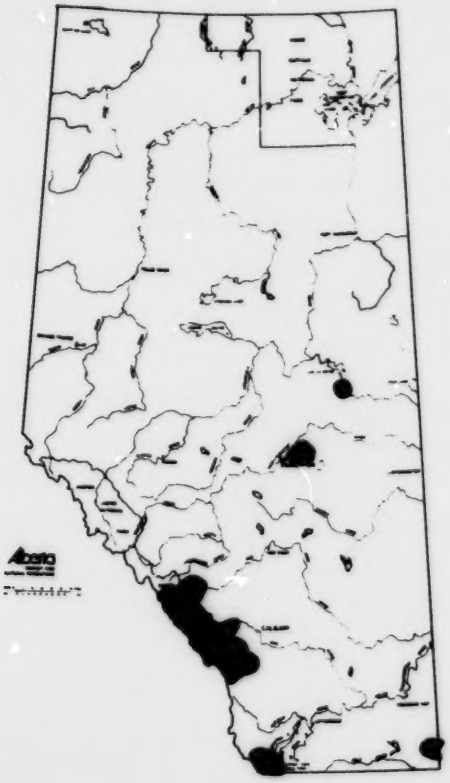
TABLE 5: Distribution of parasites within different hosts in different habitat types.

	Dictyocaulus viviparus	*Echinococcus granulosus*	*Fascioloides magna*	*Taenia hydatigena*
White-tailed Deer				
Aspen parkland	3 (33)*	0 (33)	0 (81)	4 (81)
Boreal upland & mixedwood	0 (2)	0 (2)	0 (13)	1 (13)
East slopes & foothills	0 (3)	0 (3)	2 (18)	1 (18)
Grasslands	0 (18)	0 (18)	0 (35)	1 (35)
Wapiti				
Aspen parkland	0 (1)	0 (1)	0 (2)	0 (2)
Boreal upland & mixedwood	2 (20)	0 (20)	1 (32)	1 (32)
East slopes & foothills	2 (18)	6 (18)	20 (41)	0 (41)
Grasslands	1 (2)	0 (2)	0 (19)	1 (15)
Moose				
Aspen parkland	(0)	(0)	0 (2)	1 (2)
Boreal upland & mixedwood	7 (33)	14 (33)	0 (116)	73 (116)
East slopes & foothills	0 (17)	5 (17)	6 (80)	45 (80)
Grasslands	(0)	(0)	(0)	(0)
Mule Deer				
Aspen parkland	4 (43)	0 (43)	0 (70)	9 (70)
Boreal upland & mixedwood	4 (24)	0 (24)	0 (50)	12 (50)
East slopes & foothills	5 (19)	0 (19)	0 (31)	4 (31)
Grasslands	4 (36)	0 (36)	0 (112)	10 (112)

*Number infected (Number examined).



5. Giant liver flukes beside a capsule in the liver of a Wapiti. Flukes are most often found in pairs within the capsules.



6. Distribution of *F. magna* in Alberta. Note the occurrence in Cypress Hills and Elk Island Park.

in Moose and White-tailed Deer sharing range with infected Wapiti. In spite of extensive examination of Wapiti livers by hunters, there are no previous records of F. magna occurring in the central mountains and foothills of Alberta outside Banff National Park. Our results indicate that the parasite has spread beyond the park boundaries into the Siffleur, Ya Ha Tinda, Spray Lakes, and Highwood regions. This dispersal of liver flukes coincides with natural dispersal and migration patterns of Wapiti within the region (Morgantini and Hudson 1988; Woods 1988) and further supports other reports that F. magna readily moves with its hosts into new areas.

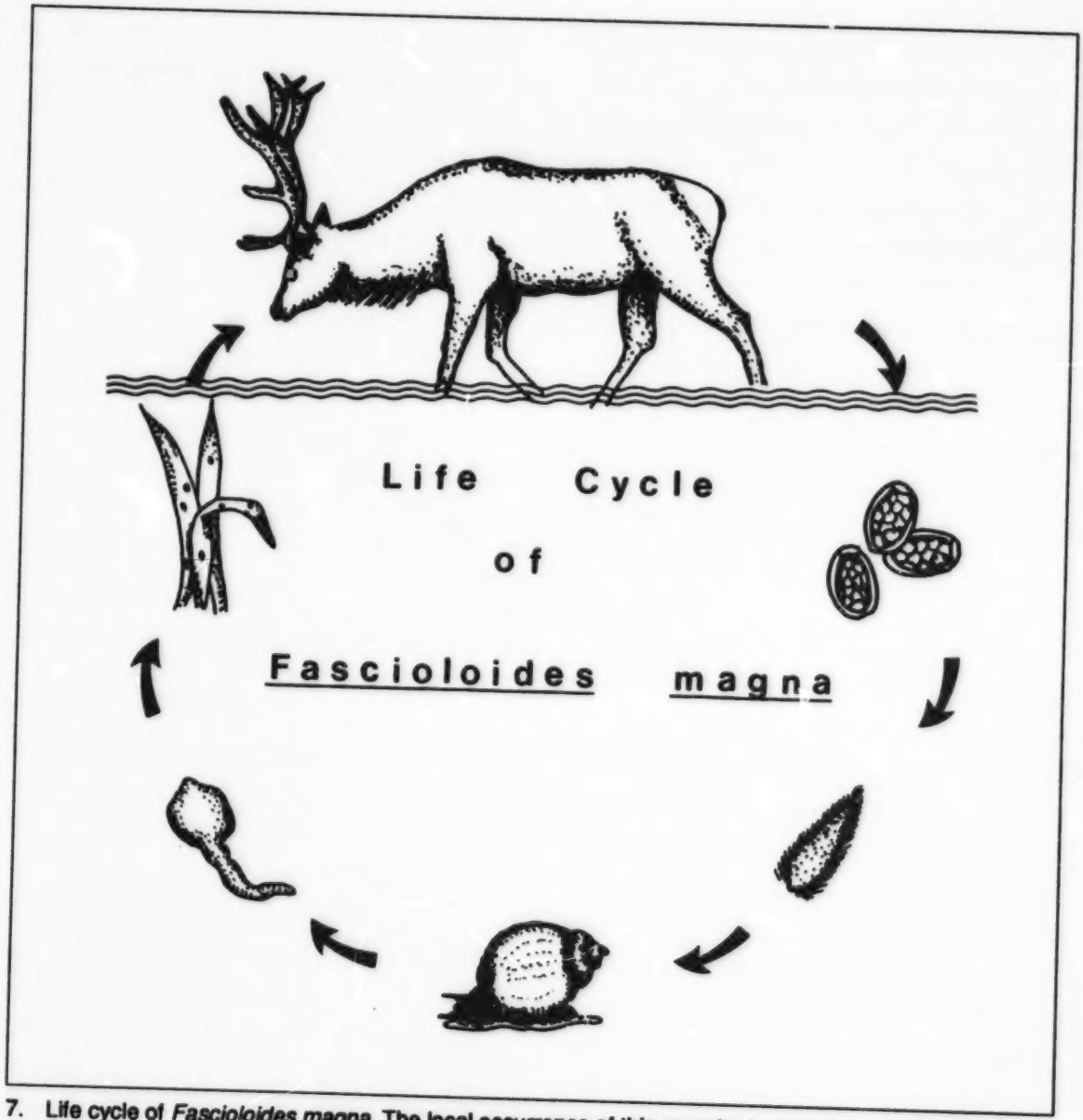
In the extreme southwestern part of Alberta, the giant liver fluke has been reported in Wapiti from Waterton Lakes National Park (Flook and Stenton 1969) and was found in 63% of 16 adult Wapiti killed by hunters in the Waterton area in 1984 (Kingscote et al. 1987). It probably is present throughout the western uplands south of the North Saskatchewan River. [Further sampling in the Livingstone and Clearwater areas in 1989 has confirmed this.]

This is the first confirmed report of F. magna in the Cypress Hills of southeastern Alberta and southwestern Saskatchewan. Wobeser et al. (1985) reported operculate fluke eggs in 10 of 50 faecal samples from Wapiti in the Saskatchewan portion of the Cypress Hills but were unable to determine their identity. The eggs were smaller than most eggs of F. magna and the livers of the Wapiti were not available for examination. In addition, Samuel et al. (1976) did not find liver flukes in 23 Moose from the Alberta portion of the Cypress Hills. The area is an isolated region of boreal upland habitat surrounded by prairie grasslands. It appears F. magna is present at very low levels and is unlikely to have significant impact on Moose or Wapiti in the Cypress Hills.

It is significant that F. magna was not found in deer collected from Camp Wainwright in east central Alberta. In 1923, "several" Bison (Bison bison) livers from Buffalo National Park were examined and found to contain giant liver flukes (Cameron 1923). Reports filed by Parks Canada personnel in 1931 and 1932 indicated the number of infected ruminants in the park was increasing. By 1933 many Wapiti and deer were "heavily" infected with F. magna (Swales 1935) and the parasite was a major problem for wildlife managers.

Measures to eradicate the giant liver fluke from the park were undertaken in the late 1930s. Knowing that the life cycle of F. magna involves water and aquatic snails (Figure 7), park managers selected a few swamps and lakes and treated them with copper sulphate to destroy snail populations (Swales 1935). In addition, over 5000 cervids in the park, mainly Wapiti and some Bison were slaughtered in an attempt to control flukes and other disease problems, particularly brucellosis and tuberculosis (Lothian 1981).

Liver flukes were not observed during cursory examination of large numbers of livers of hunter-killed White-tailed Deer and Mule Deer from Camp Wainwright between 1966 and 1987 (W.D. Wishart, pers. comm., 1989), nor in the 40 White-tailed Deer and 40 Mule Deer examined during the current (1988) survey. It is apparent that the combined methods of the 30s were successful in eradicating F. magna from the area. However, given the tremendous environmental impact of such methods (i.e., copper sulfate kills a wide range of aquatic life), they are unlikely to be used in a modern situation.



7. Life cycle of *Fascioloides magna*. The local occurrence of this parasite is always focused around wetlands.

4.2 Management Implications of Fascioloides Magna

The high number of F. magna in some Wapiti indicates there is a good potential for the release of large numbers of eggs into the environment, thus promoting further spread of the parasite in suitable habitats. In order for giant liver fluke to complete its life cycle, such areas must include permanent or temporary waterbodies with abundant snail populations and submerged or emergent vegetation. At present the parasite is not a problem in free-ranging ungulate populations in Alberta. However, once established in suitable habitats, it could become a threat to moose populations.

Natural Dispersal: The giant liver fluke appears to be dispersing naturally within the mountains and foothills regions. The speed and extent of the spread is limited by the availability of wetland habitat, the density of free-ranging ungulates, and the proportion of suitable hosts that are infected. Data indicate that it took 10 to 15 years for F. magna to become a serious problem in Banff National Park: an area of extensive wetlands and high density of wapiti. Given the current conditions in southwestern Alberta, we can predict a slow but steady increase in the parasite population. For this reason, ungulate populations in upland areas south of the North Saskatchewan River should be monitored every 5 to 10 years.

Translocation: F. magna is translocated readily with infected Wapiti and White-tailed Deer. Artificial movement of animals can introduce enough eggs and adult worms to add to or establish a local population of liver flukes in the new area, particularly if translocated animals are maintained at a high density. Free-ranging populations adjacent to, or sharing range with, translocated animals also would become infected. The effects would not be obvious immediately but would accumulate over time. Spread of the giant liver fluke by artificial movement of infected animals should be avoided.

Diagnostic tests for F. magna involving examination of faecal samples for fluke eggs (Foreyt 1981; Wobeser et al. 1985) can be used to identify most infected individuals. In addition, an anthelmintic successful at killing giant liver flukes in Wapiti is under investigation (Pybus, unpubl. data).

As detailed earlier, information in the 1988 survey indicates that F. magna currently is not a problem in free-ranging populations but probably will increase in wetland habitats in southwestern Alberta. Artificial movement of infected animals should be avoided, since this will increase the spread of the parasite..

4.3 Other Parasites

Results in this survey concerning parasites other than F. magna generally provide an update of the information of Flook and Stenton (1969), Samuel et al. (1976), Stock and Barrett (1983), and Kingscote et al. (1987). However, the current (1988) results differ in that our samples were collected over a much wider geographic area and provide information concerning more general patterns of host and geographic distribution.

Thread lungworm (Figure 8) was the most widespread parasite and was found throughout the range of hosts and habitats

examined. As noted in other reports, these nematodes were more common in yearling and young-of-the-year animals.

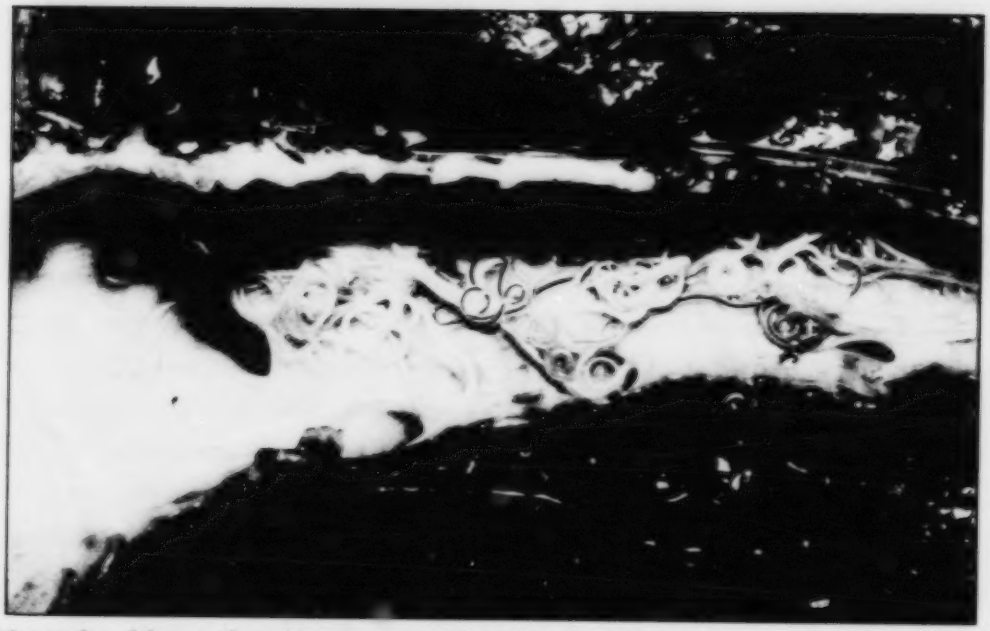
Larvae of the tapeworms I. hydatigena and E. granulosus (Figure 9) were most often found in Moose, particularly in the Swan Hills (76% of 34 and 73% of 11 adults sampled, respectively). A similarly high prevalence of these larvae in Moose in the Swan Hills was reported by Samuel et al. (1976). Fuller and Keith (1980) reported high Wolf (Canis lupus) populations in the area in the late 1970s. Since Wolves also are an important part of the life cycle of these worms (Figure 10), the data probably reflect continued high populations of wolves in north central Alberta. Similarly, in southwestern Quebec, high levels of hydatid cysts in Moose were correlated with high densities of Wolves (Messier et al. 1989). As shown in other studies, the prevalence and intensity of cysts increased with an increase in the age of infected Moose (Ritcey and Edwards 1958; Rausch 1959; Addison et al. 1979; McNeill and Rau 1987; Messier et al. 1989; present study).

Significant numbers of Mule Deer in the parkland (12.9%) and grassland (8.9%) regions also were infected with I. hydatigena. Coyotes (Canis latrans) likely replace Wolves as the definitive hosts in these areas. Very few Wapiti or White-tailed Deer were infected with tapeworm larvae.

Echinococcus granulosus infections were restricted to upland and northern mixedwoods habitats and were not found in Mule Deer or White-tailed Deer. Since all four host species share range in these habitats, the results suggest that the life cycle of hydatid tapeworms is dependent upon Moose and/or Wapiti as suitable intermediate hosts. Heavily infected Moose and Wapiti often had cysts in the liver as well as the lungs.

The apparently low prevalence of the fringed tapeworm in this study probably is an underestimation of its presence in host populations. This tapeworm normally occurs in the biliary (bile) system of the liver of infected hosts. However, it moves rapidly into the small intestine after death of the host and usually is found in the stomach or small intestine (Allen 1973; Stock and Barrett 1983). Thus, since the stomach and intestines were not examined, many infected animals could have been missed in the current study. The high proportion of infected livers in animals from the upland habitats suggests the parasite is abundant in southwestern Alberta and the Cypress Hills. A similarly high prevalence has been reported in Moose (Samuel et al. 1976; Stock and Barrett 1983) and Wapiti (Stock and Barrett 1983) from the Cypress Hills.

Adult lancet fluke has not been reported previously from cervids in Canada. It is found commonly in domestic sheep and cattle and a variety of wild ruminants throughout Europe and is distributed widely in domestic species in North America. However, reports from wild cervids in North America are limited (Mapes and Baker 1950; Schulte et al. 1976). The only previous record of D. dendriticum from western Canada is from cattle in British Columbia (Lewis 1974). The fluke is small and inconspicuous and easily could be overlooked during routine necropsies. Its presence in Wapiti and deer in the Cypress Hills suggests local abundance in domestic species, probably sheep or cattle, with shared use of contaminated range.



8. *Dictyocaulus viviparus*, thread lungworms, coiled within the airway of the lung of a White-tailed Deer.

9. *Echinococcus granulosus* cysts in the lungs of a Wapiti. The parasite occurs as a clear, fluid-filled 'blister'.

10. Life cycle of *Echinococcus granulosus*. This parasite cycles between an herbivore (the ungulate) and a carnivore (the wolf).

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APPENDIX

Appendix 1. Location of samples examined for parasites, fall 1988.

WMU	Wapiti	Moose	Mule Deer	White-tailed Deer	TOTAL
102	0	0	11	2	13
104	0	0	7	2	9
106	0	0	3	2	5
108	0	0	9	9	18
110	0	0	10	4	14
112	0	0	0	1	1
116	9	0	15	5	29
118	2	0	11	1	14
119	8	0	16	5	29
124	0	0	0	2	2
130	0	0	2	0	2
132	0	0	2	0	2
148	0	0	3	0	3
150	0	0	1	0	1
151	0	0	3	1	4
152	0	0	16	0	16
160	0	0	1	0	1
164	0	0	1	1	2
166	0	0	1	0	1
200	0	0	1	1	2
206	0	0	1	0	1
208	0	0	0	1	1
220	0	0	6	4	10
221	0	0	2	0	2
224	0	0	0	1	1
230	0	0	1	1	2
232	0	0	4	1	5
234	0	0	1	0	1
238	0	0	6	4	10
242	0	0	0	2	2
248	0	1	4	11	16
250	0	0	2	0	2
254	0	0	0	6	6
256	0	0	0	1	1
258	0	0	2	8	10
300	0	2	2	0	4
302	0	6	0	0	6
304	1	4	0	0	5
305	1	0	2	1	4
306	0	2	1	0	3
308	0	4	0	0	4
310	0	2	0	0	2
312	1	9	0	0	10
314	4	6	9	6	25
316	0	4	3	0	7

Appendix 1 (continued)

WMU	Wapiti	Moose	Mule Deer	White-tailed Deer	TOTAL
318	0	4	5	1	10
320	0	2	0	0	2
324	0	2	4	1	7
326	1	2	0	1	4
328	1	1	0	0	2
330	0	1	1	0	2
332	1	3	0	0	4
336	0	1	0	0	1
339	1	2	0	0	3
340	1	4	0	0	5
344	0	2	0	0	2
346	0	4	1	1	6
348	0	2	0	0	2
350	0	40	5	0	45
351	0	5	0	0	5
354	1	6	0	0	7
356	0	5	0	0	5
358	0	3	0	0	3
359	0	2	0	0	2
400	0	12	0	0	12
402	0	7	0	0	7
404	5	6	0	0	11
406	0	4	0	0	4
408	7	2	1	0	10
410	17	3	6	9	35
412	0	1	0	0	1
416	0	0	1	0	1
417	0	0	0	1	1
418	3	0	1	0	4
420	1	0	0	0	1
426	1	0	0	0	1
438	0	1	0	0	1
441	0	1	0	0	1
500	0	0	0	3	3
502	0	0	0	1	1
504	0	0	1	0	1
507	0	0	1	0	1
509	0	4	0	0	4
512	0	4	0	1	5
514	0	1	0	0	1
518	0	5	0	1	6
521	0	4	0	2	6
524	0	6	0	2	8
526	0	1	0	0	1
530	0	4	0	0	4

Appendix 1 (continued)

WMU	Wapiti	Moose	Mule Deer	White-tailed Deer	TOTAL
536	0	1	0	0	1
936	2	0	0	0	2
Camp Wainwright	0	0	40	40	80
Cypress-Saskatchewan	26	0	37	0	63
TOTAL	94	198	263	147	702

Appendix 2. *Fascioloides magna* in survey samples.

Species	N	WMU	AGE	SEX	# Flukes
Wapiti	21	312	AD	M	115
		314	AD	F	1
		404	AD	F	2
		404	AD	F	6
		408	AD	F	7
		408	AD	M	1
		408	AD	M	78
		410	YLG	M	1
		410	YLG	NR	36
		410	AD	F	55
		410	AD	M	10
		410	AD	M	13
		410	AD	M	16
		410	AD	M	19
		410	AD	M	24
		410	AD	M	3
		410	AD	M	608
		410	AD	M	68
		418	AD	F	6
		426	AD	M	+
		Cypress	AD	F	8
Moose	6	300	AD	F	5
		312	AD	F	4
		312	AD	M	+
		314	AD	F	+
		404	AD	M	4
		410	AD	M	2
White-tailed Deer	2	410	AD	F	31
		410	AD	M	3

+ Presence based on liver damage or partial liver sample.

NR Sex not recorded.